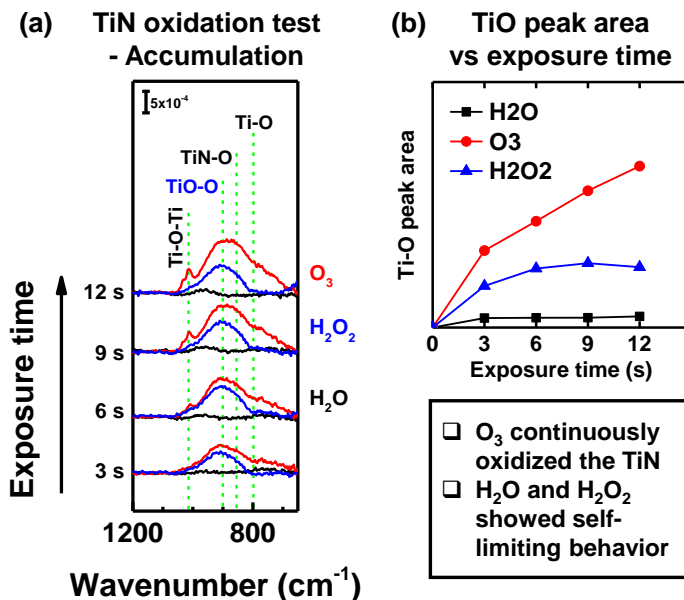


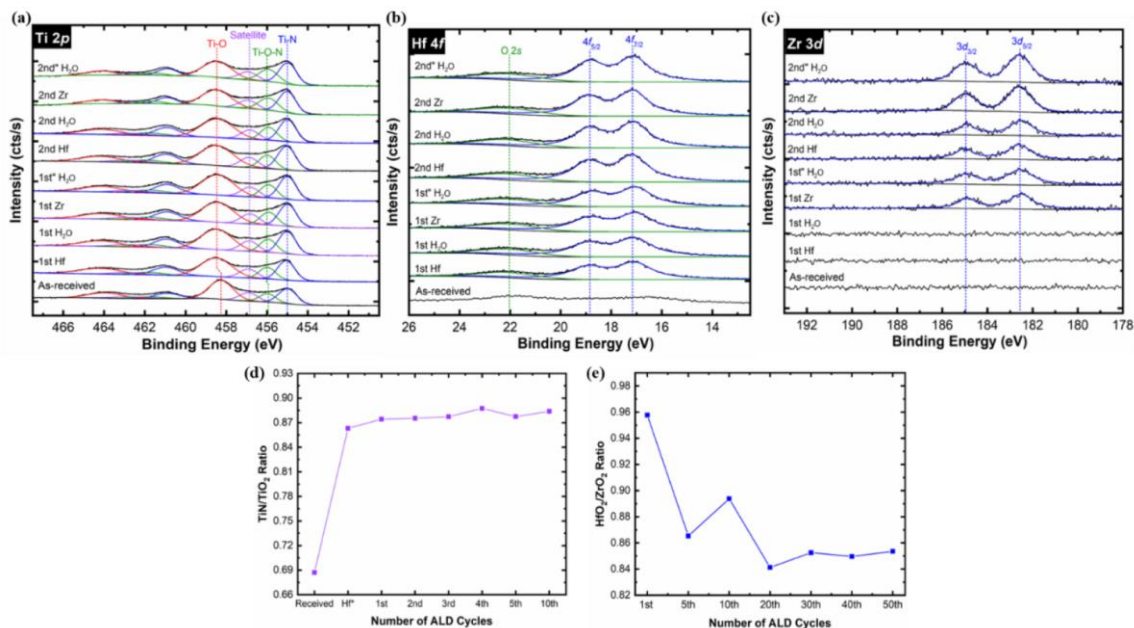
Supplemental

## The Impact of Oxygen Source on the Formation of TiN Interface at the Initial Stage ALD process of Hafnia-based Ferroelectrics: An *in-situ* Analysis

Jin-Hyun Kim et al.



**Figure 1.** (a) Accumulation spectra acquired using *in-situ* RAIRS system exposing H<sub>2</sub>O, O<sub>3</sub>, and H<sub>2</sub>O<sub>2</sub> on TiN surface at 250 °C. (b) Peak area change from 600 to 1100 cm<sup>-1</sup> wavenumber after exposing oxidants versus exposure time showing the increase of interface on TiN.



**Figure 2.** XPS spectra of (a) Ti 2p, (b) Hf 4f, and (c) Zr 3d from the initial TiN surface, after TDMA-Hf exposure, H<sub>2</sub>O exposure up to two ALD cycles. (d) TiN and TiO ratio in Ti 2p spectra before and after each ALD cycle shows the increase of TiO interface formation, especially on the first cycle. (e) Hf and Zr ratio versus the number of ALD cycles. [1] Ava Khosravi, PhD thesis, The University of Texas at Dallas (2020).